

detach themselves from the internal surface of the ectoderm in the middle of the dorsal region, elongating and attaching themselves to the velum on the one hand, and to the apex of the rudiment of the shell on the other.

The branchial cavity is a depression of the ectoderm, which is produced between the margin of the shell and the neck of the larva on the dorsal side behind the anus, which is situated to the right. The mucus-gland is originally a depression of the ectoderm in the middle of the upper surface of the foot. The larvæ brought up in captivity all die at this degree of development: the sequel of their evolution has not yet been observed in a manner complete enough to be the subject of a communication.—*Comptes Rendus*, September 13, 1875, p. 472.

*On the Sexual Reproduction of the Vorticellians.*

By M. BALBIANI.

Since the time of Spallanzani (1776) it has been generally admitted that the Vorticellians are reproduced by gemmiparity or external budding. Professor Stein, of Prague, has the merit of having shown that this belief only rested on an illusion, and that what was taken for a bud separating itself from the parent was in reality the conjugation of two individuals of unequal size fusing into a single animalcule. M. Stein sees in this phenomenon a multiplication of the Vorticellians by sexual reproduction, and, as the description which he gives of it differs considerably from the picture which I have traced of this mode of reproduction in the other Infusoria, he uses it as a weapon for attacking my works on this subject. Let us first see how M. Stein describes the facts which he has observed, and take for example his observations concerning a Vorticellian living in a colony, and one of the most widely spread, namely *Carchesium polypinum*.

By successive and rapid binary divisions a certain number of individuals of the colony break up into groups composed of four or eight individuals, the size of which is, in consequence, four or eight times as small as that of the ordinary individuals. They remain at first united at the extremity of their common peduncle, and then detach themselves from it successively by the agitation of the cilia which form a crown at their posterior extremity.

As soon as it is free, each of these little individuals, or *microgonidia* (the name given to them by M. Stein), whirls rapidly about between the branches of the bush formed by the colony, and at last makes choice of one of the large ordinary individuals, on the side of which it fixes itself by its posterior extremity. The body-walls of the two individuals are absorbed at the point of contact; and they then communicate freely by their central cavities. During this time the elongated and cylindrical nucleus of each is divided into a number of small rounded fragments, which are dispersed irregularly in the internal parenchyma. Soon after, all the contents of the micro-

gonidium, the parenchyma with the nuclear fragments, are seen to pass slowly into the body of the large individual and mix with its substance. The microgonidium is then reduced to its external envelope, empty and folded together; and this latter also at length penetrates to the interior of the other individual, where it disappears without leaving any trace.

After mingling in the body of the individual resulting from the conjugation, the fragments of the two nuclei approach one another, and are fused into a common mass, to which M. Stein gives the name of *placenta*. In the centre of this mass appear nucleated spheres (*Keimkugeln*), which, in their turn, produce in their interior mobile bodies furnished with vibratile cilia, which M. Stein regards as the embryos of the *Carchesium polypinum*. These embryos escape from the mother by a special canal of parturition, while the unemployed portion of the placenta lengthens and reconstitutes the nucleus.

Such is, in few words, the manner in which M. Stein describes the reproduction of *Carchesium* and of several other Vorticellians which presented analogous phenomena. This description, indeed, presents some considerable differences from that which I have given of the sexual reproduction in the other Infusoria. It will be remarked, above all, that there is no mention of the *nucleolus*, to which I ascribe so important a part in this latter mode of multiplication, since, according to me, it represents the male organ or testis of the Infusoria. And, in fact, not only does M. Stein deny the existence of the nucleus in all the Vorticellians, but in them he expressly attributes the formation of the germinative spheres and of the embryos which proceed from them to the copulation of the nuclear fragments of different origin, a copulation which he interprets as a true fecundation.

If things really occurred as M. Stein asserts, it would be necessary to suppose one of two things—either the Vorticellians are reproduced in accordance with other laws than those which govern the other Infusoria, or else my observations are not correct. The absence of a fecundation by filiform spermatozooids originating in the nucleolus, would, above all, establish between them a difference of the first importance. I hasten to say that there is nothing of the kind. It is a long time since I described and figured the nucleolus in several Vorticellians, amongst which is *Carchesium polypinum*; and my observations on that subject have been confirmed by M. Engelmann.

I can only confirm all that M. Stein says of the formation of the small individuals or microgonidia by successive binary divisions of a single animalcule. I have seen, like him, these little products of division abandon, one at a time, their common peduncle, and, after a few moments of brisk agitation in the liquid, enter into conjugation with the sedentary individuals. This conjugation is not effected without a certain resistance on the part of these latter, if we may judge from the quick contractions of their peduncle at each contact of

the microgonidium. Moreover, in order to avoid being projected to a distance, and to keep always near the individual with which it wishes to conjugate; the microgonidium fixes itself on the anterior part of the peduncle of the latter by a thin filament which it secretes from its posterior part. It succeeds at length in attaching itself, by this posterior part acting as a sucker, to a point of the surface of the large individual, most frequently at a little distance above its insertion on the peduncle. The microgonidium is furnished with an elongated nucleus, and it possesses besides a nucleolar corpusele resembling that of the other individual. It is at the moment when the cavities of the bodies of the two conjugated animalcules begin to be put in communication, after the absorption of the parietal surfaces in contact, that the division of their respective nuclei into smaller and smaller and more numerous fragments begins, as M. Stein has described it. At the same time the nucleole in the microgonidium is seen to enlarge and divide into two secondary nucleoli, each of which is transformed into a voluminous ovoid capsule, in which appear numerous filaments of extreme tenuity, arranged parallel to one another. The transformations of the nucleolus and the nature of its contents are identical in all points with what we observe in the other Infusoria during sexual reproduction; we must therefore conclude that in the conjugation of the Vorticellians the nucleolus plays the same part as in these latter (that is to say, that of the male organ), and that the filaments developed in its interior represent the spermatozoids of these animalcules.

In the other individual the nucleolus does not undergo the same modifications, but preserves, during the whole of the conjugation, its initial rudimentary state. After all the substance of the microgonidium has passed into the cavity of the conjoint individual, we find in the interior of the latter, with the mingled fragments of the two nuclei, the seminal capsules of the microgonidium, easily recognizable by their striated appearance, due to the presence of the spermatie filaments. The aspect which the individual presents at this moment entirely recalls that of a *Paramecium* which has just copulated, at the phase in which the nucleus is divided into numerous fragments; and in the same way also as in this latter species, some only of the nuclear fragments (from five to seven) become complete ova, while the rest approach one another to reconstitute the nucleus. I have never seen these fragments fuse together to form a placenta, in the interior of which the living embryos originate, as M. Stein describes. We must therefore believe that, in his present observations, this naturalist has again been the victim of one of those illusions which led him formerly to introduce, into the genetic eyele of the *Paramecia*, *Stylonychia*, and other Infusoria, creatures connected with them by simple relations of parasitism, as has been shown by my old observations, confirmed by those of M. Metschnikoff and the quite recent observations of M. Bütschli.—*Comptes Rendus*, October 18, 1875, p. 676.